What is claimed is:

1. A device, comprising:

a first layer that includes at least one magnetic material from the group consisting of ferromagnetic materials and ferrimagnetic materials;

a MgO tunnel barrier on and in contact with the first layer; and

a second layer that includes semiconductor material, the second layer being on and in contact with the MgO tunnel barrier, the MgO tunnel barrier being sandwiched between the first layer and the second layer, thereby forming a first spintronic element, wherein the first layer, the MgO tunnel barrier, and the second layer are configured to permit spin polarized charge carriers to be injected into the semiconductor.

2. The device of Claim 1, wherein at least one of the first layer and the second layer includes a spacer layer in contact with the MgO tunnel barrier, wherein the spacer layer does not substantially interfere with the tunneling properties of the MgO tunnel barrier, thereby allowing charge carriers to substantially maintain their spin polarization as they pass through the spintronic element.

3. The device of Claim 1, wherein the first layer includes a ferromagnetic material.

4. The device of Claim 3, wherein the ferromagnetic material includes Fe.

5. The device of Claim 3, wherein the ferromagnetic material includes an alloy of Co and Fe.

6. The device of Claim 5, wherein the Fe concentration is between 8 and 50 atomic %.

7. The device of Claim 5, wherein the Fe concentration is between 12 and 25 atomic %.

8. The device of Claim 3, wherein the ferromagnetic material is an alloy of at least 2 metals selected from the group consisting of Ni, Fe, and Co.

9. The device of Claim 8, wherein the ferromagnetic material is bcc and substantially (100) oriented.

10. The device of Claim 3, further comprising a layer of antiferromagnetic material, the ferromagnetic material being exchange biased by the antiferromagnetic material.

11. The device of Claim 10, wherein the antiferromagnetic material includes an alloy selected from the group consisting of Ir-Mn and Pt-Mn.

12. The device of Claim 3, wherein the layer of ferromagnetic material has a shape that is generally longer in one direction than in another direction, thereby fixing the magnetic moment of the ferromagnetic material through shape magnetic anisotropy.

13. The device of Claim 3, further comprising:

a first lead that is in electrical communication with the semiconductor material; and

a second lead that is in electrical communication with the ferromagnetic material, the leads providing voltage across the spintronic element to enable the injection of spin polarized charge carriers into the spintronic element.

14. The device of Claim 13, further comprising antiferromagnetic material that is in electrical communication with both the ferromagnetic material and the second lead.

15. The device of Claim 1, wherein the semiconductor is GaAs.

16. The device of Claim 15, wherein the MgO tunnel barrier is in direct contact with both GaAs and the magnetic material.

17. The device of Claim 1, wherein the semiconductor is selected from the group consisting of $Al_xGa_{1-x}As$, $In_yGa_{1-y}As$, ZnSe, GaN, InGaN, GaNInAs, GaSb, InGaSb, InP, InGaP, Si, Ge, SiGe, and heterostructures thereof, in which x and y are between 0 and 100%.

18. The device of Claim 1, wherein the MgO tunnel barrier is substantially (100) oriented.

19. The device of Claim 3, wherein the MgO tunnel barrier and the ferromagnetic material are both substantially (100) oriented, and the ferromagnetic material is bcc.

20. The device of Claim 1, wherein the MgO tunnel barrier has a thickness of between 3 and 50 angstroms.

21. The device of Claim 1, further comprising a second spintronic element in electronic communication with the first spintronic element, the first and the second spintronic elements together forming respective devices for spin injection and spin detection.

22. The device of Claim 1, wherein the first layer, the MgO tunnel barrier, and the second layer are configured so that, upon application of a voltage across the device, the spin polarization of current injected from the MgO tunnel barrier into the semiconductor is greater than 20%.

23. The device of Claim 1, wherein the first layer, the MgO tunnel barrier, and the second layer are configured so that, upon application of a voltage across the device, the spin polarization of current injected from the MgO tunnel barrier into the semiconductor is greater than 40%.

24. A device, comprising:

a first layer that includes at least one magnetic material from the group consisting of ferromagnetic materials and ferrimagnetic materials, the first layer having a surface that is substantially free of oxide formed from the first layer;

a MgO tunnel barrier on and in contact with the surface of the first layer; and

a second layer that includes semiconductor material, the second layer having a surface that is on and in contact with the MgO tunnel barrier, the MgO tunnel barrier being sandwiched between the first layer and the second layer.

25. The device of Claim 24, wherein the surface of the overlayer is substantially free of oxide formed from the overlayer.

26. The device of Claim 24, wherein at least one of the overlayer and the underlayer includes a spacer layer that is in contact with the MgO tunnel barrier, wherein the spacer layer does not substantially interfere with the tunneling properties of the MgO tunnel barrier.

27. The device of Claim 24, wherein the MgO tunnel barrier has a thickness of between 3 and 50 angstroms.

28. The device of Claim 24, wherein:

i) the amount of any oxide separating the MgO tunnel barrier from the overlayer and the underlayer is sufficiently low, and

ii) the MgO tunnel barrier, the underlayer, and the overlayer are sufficiently free of defects,

that the spin polarization of current injected from the MgO tunnel barrier into the semiconductor is greater than 20%.

29. The device of Claim 24, wherein:

i) the amount of any oxide separating the MgO tunnel barrier from the overlayer and the underlayer is sufficiently low, and

ii) the MgO tunnel barrier, the underlayer, and the overlayer are sufficiently free of defects,

that the spin polarization of current injected from the MgO tunnel barrier into the semiconductor is greater than 40%.

30. A method of using the device of Claim 1, comprising:

flowing charge carriers from a surface of the semiconductor through the MgO tunnel barrier and into the magnetic material, wherein the charge carriers undergo spin dependent tunneling through the MgO tunnel barrier; and

detecting the spin polarization of the charge carriers.

31. The method of Claim 30, wherein the charge carriers include electrons.

32. The method of Claim 30, wherein the charge carriers include holes.

33. The method of Claim 30, wherein the magnetic material includes a ferromagnetic material.

34. The method of Claim 30, wherein the semiconductor material includes GaAs.

35. A method of using the device of Claim 1, comprising:

applying a voltage across the device, so that a potential difference is established between the magnetic material and the semiconductor material, thereby inducing the flow of spin-polarized charge carriers from the magnetic material into the semiconductor material.

36. The method of Claim 35, further comprising applying an electromagnetic field to change the direction of the spin of the charge carriers.

37. The method of Claim 35, wherein the charge carriers include electrons.

38. The method of Claim 35, wherein the charge carriers include holes.

39. The method of Claim 35, wherein the magnetic material includes a ferromagnetic material.

40. The method of Claim 35, wherein the semiconductor material includes GaAs.

41. A method, comprising:

forming a MgO tunnel barrier on a surface of an underlayer, wherein the surface is selected to be substantially free of oxide; and

forming an overlayer on the MgO tunnel barrier to construct a spintronic element, with one of the underlayer and the overlayer including a layer of semiconductor material, and the other of the underlayer and the overlayer including a layer of magnetic material selected from the group consisting of ferromagnetic materials and ferrimagnetic materials, wherein the MgO tunnel barrier is sandwiched between the underlayer and the overlayer.

42. The method of Claim 41, wherein the MgO tunnel barrier is in direct contact with both the semiconductor material and the magnetic material.

43. The method of Claim 41, wherein at least one of the underlayer and the overlayer includes a spacer layer that is in contact with the MgO tunnel barrier, wherein the spacer layer is selected to not substantially interfere with the tunneling properties of the MgO tunnel barrier, thereby allowing charge carriers to substantially maintain their spin polarization as they pass through the spintronic element.

44. The method of Claim 41, wherein the magnetic material includes a ferromagnetic material, and the spintronic element further includes a layer of antiferromagnetic

material, the ferromagnetic material being exchange biased by the antiferromagnetic material.

45. The method of Claim 41, further comprising annealing the spintronic element to increase the spin polarization of charge carriers passed through the element.

46. The method of Claim 45, wherein the charge carriers include electrons.

47. The method of Claim 45, wherein the charge carriers include holes.

48. The method of Claim 41, wherein the MgO tunnel barrier is substantially (100) oriented.

49. The method of Claim 48, wherein the magnetic material includes ferromagnetic material, the ferromagnetic material being bcc and substantially (100) oriented.

50. The method of Claim 41, said forming a MgO tunnel barrier including: depositing Mg onto the surface of the underlayer to form a Mg layer thereon; and directing additional Mg, in the presence of oxygen, towards the Mg layer to form a MgO tunnel barrier in contact with the underlayer, the oxygen reacting with the additional Mg and the Mg layer.

51. The method of Claim 50, wherein the thickness of the Mg layer is selected to be large enough to prevent oxidation of the underlayer but small enough that, upon reaction of the oxygen with the Mg layer, substantially all the Mg in the Mg layer is converted into MgO.

52. The method of Claim 50, further comprising annealing the MgO tunnel barrier to improve its tunneling characteristics.

53. The method of Claim 50, wherein the Mg layer is deposited in the absence of substantial amounts of reactive oxygen.

54. The method of Claim 41, wherein the MgO tunnel barrier has a thickness of between 3 and 50 angstroms.